Transformations of a Carabid (Plochionus timidus), *and observations on a Coccinellid enemy of the red spider.*

By J. C. Duffey.

(Presented October 20th, 1890.)

Among the many insect pests that damage the foliage of our forest and shade trees, the fall web-worm (*Hyphantria cunea*, Drury) is probably one of the worst. It not only destroys the foliage, but covers the tree with its web, making a very ugly sight. The great damage done by this insect gives us a special interest in its enemies. Charles V. Riley mentions* the following insect enemies of *H. cunea:* External—*Mantis carolina*, *Prionidus cristatus*, *Euchistus servus*, and *Poidesus spinosus.* True parasites—*Telenomus bifidus* (an egg-parasite), *Metorus hyphantriæ*, *Apanteles hyphantriæ*, *Limneria pallipes*, and *Tachina*, sp.

At the Missouri Botanical Garden, during the present season, three other enemies of *H. cunea* have been observed: one of the jumping spiders (Aranidæ), the larva of a lace-wing fly (*Chrysopa*) feeding on both eggs and larvæ, and a beetle, *Plochionus timidus*, Hald. The life-history of the latter is of interest not only on account of its preying upon one of our worst tree-defoliators, but also as the life-history of no species in this genus has hitherto been described, while it has been traced for comparatively few of the Carabid beetles.

June 9, webs of *Hyphantria cunea* began to appear on various trees in the Garden. One of the colonies was given to one of the garden pupils, Mr. James Dunford, with instructions to rear the insects. Mr. Dunford soon found that the larvæ were disappearing, and, on examining the web, discovered several small black larvæ of some unrecognized Carabid, which were evidently the cause of the trouble, and afterward proved to be *Plochionus*

* Report of Entomologist, U. S. Dept. Agr. for the year 1886. Reprinted in Bull. No. 10, Div. Entomology, 1887.

timidus. Other webs were then examined for this insect, and from two to twenty larvæ were found in nearly every web, where they were also observed feeding on the larvæ of *H. cunea*. In many webs the *Hyphantria* larvæ were greatly diminished in numbers, and occasionally a web was found entirely uninhabited. On the 24th of June, a web of *H. cunea* was found in which were only 18 larvæ of the web-worm, but which contained an equal number of the predaceous larvæ. June 25, seven-tenths of all webs found contained larvæ of *P. timidus*. June 28, very few webs of *H. cunea* were found, and most of them were uninhabited. Where the web-worms were found, the larvæ of *P. timidus* were also invariably present. By July 1, the *Hyphantria* larvæ had disappeared.

Two beetles of *P. timidus* were found in a web of *H. cunea* in the breeding-cage on July 7th, and one flew into Mr. Dunford's window on the evening of July 31st, probably attracted by the light.

The second brood of web-worms began to appear July 22d. On the 5th of August, adults of *P. timidus* were observed in the webs, and new larvæ of this species were found three days later. Aug. 6, forty-eight webs were cut from mulberry-trees and carefully examined. Besides the *Hyphantria* larvæ, the following insects were found: *P. timidus*, 8 beetles and 7 larvæ; 7 *Chrysopa* larvæ; 5 spiders; and 1 adult Coccinellid.

A careful search was made about this time for the eggs of *Plochionus*. Aug. 11, Mr. Dunford found, in a web of *H. cunea*, a small white foreign egg. Having seen one, it was not difficult to find others, and thirty-two eggs were found in the portion of a web covering a single mulberry leaf. Aug. 18, other eggs of *P. timidus* were found in a web of *H. cunea*. These eggs must have been laid several days after the hatching of the *Hyphantria* eggs, as they were distributed through a portion of the web covering several mulberry leaves, and the *Hyphantria* larvæ must have been feeding for some time to have extended their web so far. Aug. 29th, half-grown larvæ, full-grown larvæ, and the imago of *P. timidus* were found in *Hyphantria* webs. The last *Plochionus* larva found in a web was discovered Sept. 4. This larva pupated Sept. 11, and on the 24th had assumed the form of

the imago, but still within the pupa case.* Aug. 9, eight of the supposed eggs of *P. timidus* were placed in a web of *H. cunea* on a cutting of mulberry, which was set in moist sand in a six-inch pot, and covered with a bottle from which the bottom had been removed, a piece of muslin being tied over the mouth of the bottle. One egg hatched during the day, and four more during the following night. The young larvæ, which were evidently the same as those observed in the webs, began feeding on the *Hyphantria* larvæ soon after coming from the egg, Aug. 16, three of these larvæ were alive and in fine condition. All moulted during the night of Aug. 15. This was probably the second moult, the first moult not having been observed, for there is very little difference in the appearance of the larva before and after moulting, the only means of being sure of the time of moulting being to find the cast skin, which is a difficult task when the larvæ are in the webs.

From the 16th to the 17th of the month the larvæ grew rapidly. They had now reached nearly full size, and very little change took place in them during the next two days, although they thickened up a little and showed more white between the dorsal plates. Aug. 21, one was removed from the cage to be sketched. They had now stopped feeding, and during the next three days they dug into the sand somewhat. During this time one of them died. Aug. 24, the remaining larva took a position on the inner side of a leaf that lay on the sand and remained in this position for two days, pupating on the 26th, thus completing the larval state in sixteen days. The pupa was apparently normal, but, being used to sketch from, was injured and died.

Aug. 5, a web of *H. cunea*, in which were several *Plochionus* larvæ, was placed in a pot of sand and covered with a one-gallon bell-jar having an open top over which a piece of muslin was tied, and mulberry leaves were daily placed in the jar as food for the web-worms. These leaves were soon covered by their web, after which the larvæ ate all of the enclosed leaves excepting the midrib and larger veins. Other larvæ of *P. timidus* were placed in the jar from time to time, and seemed at home in this web

* This specimen did not succeed in freeing itself from the pupa case, and died in a few days.

and grew well, but no very close observations could be made on them on account of the mass of leaf-remains spun together, in which they concealed themselves. However, some of the larvæ were in sight most of the time until Aug. 15, when none could be seen. On taking out the web, which peeled off in layers, nine pupæ and two larvæ of *P. timidus* were found. One of the larvæ pupated the next day. and the perfect beetle emerged Aug. 26. The other larva pupated Aug. 19, and the perfect beetle emerged Aug. 28.

To determine whether the *Plochionus* larvæ normally pupate in the webs, as would appear from this observation, on the 20th of August a branch of Osage orange, on which was a colony of *H. cunea* accompanied by five larvæ of *P. timidus*, was brought in and placed uncovered in a pot of sand, thus leaving the larvæ at liberty to escape if they were so inclined. Aug. 27th, a pupa was found, suspended in the web, swinging free from the foliage as if in a hammock. Sept. 4th, this pupa changed to a beetle. The web was then examined for indications of the other larvæ, and two additional beetles and one dead pupa were found in the web, leaving but one of the original five larvæ unaccounted for.

In order to observe more closely the moults, eggs were placed in deep cells on glass slides. One egg hatched in a cell Aug. 10. The larva was kept in the cell and fed on small *Hyphantria* larvæ. This larva ate and grew well for a time. It moulted Aug. 13, after which time it ate well for a few days and then sickened and died, perhaps because of its close quarters. Another larva, that came from the egg Aug. 11, was transferred to a small covered salt-cellar. This larva grew as well as those in the breeding cages. It moulted Aug. 15. There was very little change in the appearance of the larva after moulting; it then grew gradually, and moulted again Aug. 19, after which it grew rapidly, reaching about full size Aug. 24. It was quiet Aug. 28, as if about to pupate; but next morning it had escaped, the glass cover having in some way been moved a little to one side, making room for its exit. This larva should have pupated Aug. 27 to have given it the same length of time in the larval state as the one before mentioned. These facts would indicate the number of moults to be

three: one on the third or fourth day, the second four days later, and the third at the time of pupating, nine days later.

While I did not succeed in rearing perfect insects from the eggs found in *Hyphantria* webs, there is no doubt that the larvæ hatched from the above eggs were identical with those found in the webs, and from which adults of *Plochionus timidus* were reared.

I have not been able to determine the state in which this insect hibernates. These observations seem to indicate that it passes the winter as an imago, as all of the observed larvæ of the second brood either reached that state or died. While some of the larvæ dug somewhat into the sand before pupating, they did not pupate there; and those that were left undisturbed in the web were not observed to leave it. The larvæ which were seen to dig into the sand were disturbed daily by removing the debris left by the web-worms so that the *Plochionus* larvæ might be more closely observed. This is also probably the reason that all of the larvæ hatched from eggs did not go through all of their transformations, since of those brought in with the webs and not disturbed in the breeding-cage by removing any of the web, nearly all reached the imago state. There may be another brood than those studied, which might hibernate as pupæ, provided the species has other food habits than those observed; but it is not possible for another brood to have reached the pupal state in the *Hyphantria* webs. Six beetles of the sceond brood, kept in a breeding-cage with web-worms, died without laying eggs. If *Plochionus* has no other prey, it is strange that its transformations should have so long escaped observation, since the web-worm and its enemies have received considerable attention.* Yet this may be due to the local or temporary rarity of this insect at the time the published observations were made.†

* See Riley, 3 Mo. Report; and Report of Entomologist for 1886.

† The morning after this paper was presented to the Academy I received a letter from Miss Mary E. Murtfeldt of Kirkwood, Mo., who is interested in economic entomology, and whose attention I had called to this insect early in the season with a view of learning if she had made any observations on it, from which I quote the following:—

"Had you not discovered this valuable little Carabid, I should have done so, as it appeared in Kirkwood on the second brood of *Hyphantria cunea*, and in many instances depopulated the webs. Small as they are, I have seen these larvæ seize hold of an almos full-grown worm and not let go for all the contortions of the latter. I have also found them

Plochionus timidus is originally described by S. S. Haldeman* as follows:—

P. timidus.—Dull reddish-brown above; antennæ, legs, lower surface and lateral margins of prothorax and elytra, testaceous; elytra wide, deeply striate, interstices convex. 8 mill. long.

It is redescribed by Dr. Horn† as follows:—

P. timidus, Hald.—Very similar in form and color to *pallens*. The thorax rather shorter, the sides more arcuate, the hind angles more sharply rectangular. The tarsi are slender cylindrical, not flattened or sulcate above, the unguis with longer pectination. L. .28–.30 in; 7–7.5 mm. Male anterior tarsi narrowly dilated, the first three joints biseriately squamulose beneath, middle tarsi less dilated, first joint hairy beneath, the next three squamulose, anal segment bisetose each side. Female tarsi slender, anal segment with three or four setæ each side.—Pa. to Tex. and Cal.

The following descriptions of the earlier stages are drawn from a few of the many specimens observed by msyelf during the past summer:—

Newly hatched larva 3 mm. long, colorless, tapering from the head, with 13 segments exclusive of head. Ninth abdominal segment with a pair of 4-jointed cerci. Antennæ, cerci, and body, sparingly pilose.—Described from three living specimens.

Full-grown larva 10 to 15 mm. long, wider at metathorax, the number of segments unchanged. Head somewhat chitinized, light brown. Body segments with chitinized dorsal plates deepening in color to the abdomen, where they are black. Meso- and meta-thoracic segments with one small ventral and four lateral plates each. Abdominal segments with four small lateral and five ventral plates each, the latter confluent on the last three segments. Cerci of 9th segment 5-jointed. Unchitinized parts pale, the dorso-lateral plates visible from above.—Described from one living and five alcoholic specimens.

Pupa 5–6 mm. long, white and soft, distinctly showing the members of the imago; sparingly beset with spreading rusty hairs. Head inclined

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destroying the larvæ of two or three species of Tortrix and Tineid larvæ which web the leaves of oaks in the autumn. I have no doubt it will prove to be one of the most useful of predaceous insects, and I congratulate you on your discovery.

"I do not think it has appeared much to the east of St. Louis, as the ravages of the webworm in some parts of Illinois and through portions of Indiana as I passed in August last exceeded anything that I had previously seen. No mention of the Carabid was made at the meetings of the Entomological Club."

* Proceedings of the Academy of Natural Sciences of Philadelphia, vol. i p. 289.

† Amer. Entom. Soc. x. 1883, p. 145.

against the ventral surface of thorax; eyes prominent, black; antennæ partly concealed ventrad by pro- and meso-thoracic legs. Metathoracic legs covered to the tarsi by the inflexed wings.—Described from three living specimens.

Another garden and green-house pest—one to be especially dreaded in dry, hot seasons—is the little mite *Tetranychus telarius*, popularly known as the red spider. This little pest has been apparently almost free from insect enemies, so far as I can learn; the only one published being an undescribed species of the genus *Thrips*, mentioned by Mr. Theodore Pergande (Psyche, iii. 1882, p. 381). Mr. Howard tells me that "Professor Riley's unpublished notes state that a species of *Diplosis* feeds in the larval state upon these mites."

Three insects have been observed to feed on red spiders at the Botanical Garden this season: *Thrips 6-maculata*, Pergande, (MS.),*

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* This is the species mentioned by Mr. Pergande in Psyche, and of which he kindly sends me the following description:

"*Thrips 6-maculata*, n. sp.—Length of ♂, 0.6–0.8 mm.; ♀, about 1 mm. Polished. Color pale yellow, the head almost white, the thorax darkest, the prothorax often more or less distinctly marked with four small dusky spots and two oblique stripes; frequently the anterior margin of the pterothorax, its disk, and a spot near the base of all the wings, are also dusky, and also more or less of the anterior margin of the abdominal segments. The legs are usually pale yellow with only the tip of the tarsi blackish, though now and then a specimen may be met with the apex of the femora dusky and with a pale dusky spot in front and behind, at base of anterior and median tibiæ. Antennæ rather short, either pale dusky, with only the two basal joints pale yellowish, or joints 3–5 whitish, with only the apex dusky and the last three joints blackish. Joints 3–5 subequal in length, the fourth almost globular, the sixth longest and longer than the two last ones combined. Head small, scarcely twice as long as the eyes, and provided with two long, backward-curved bristles in front of the posterior ocelli. Eyes brown, prominent, large, globular, and coarsely granulated. Ocelli colorless or reddish. Prothorax longer than wide and well separated from the pterothorax, narrowest in front, not or scarcely wider than the head, its posterior angles broadly rounded and the surface quite coarsely wrinkled transversely; it is provided at the anterior angle with a long, stout, pale bristle and a small hair near it, with two similar long bristles, curved gently backward at the posterior angles, and two bristles which cross each other at the posterior margin. Abdomen smooth with segments 3–7 furnished at the posterior angle with a rather long bristle, and 6-8 similar bristles fringing the remainder of the body. Wings narrow, shorter than the body, colorless or faintly yellowish, with the veins pale dusky; the anterior pair being ornamented with three more or less distinct or well-defined dusky spots, of which the terminal one forms usually a band. One of them is placed at the inner side near the base; the second one, often elongated, in front of the middle; and the third at about the apical third of the wing. Both veins unite in the region of the median spot, and continue as a single vein to the base of the wing, and are sparsely beset with long and stiff bristles. Fringes pale dusky, stiff, and rather sparsely distributed, being more dense and longer along the posterior edge.—Found on many different plants infested with red spider, on which it has repeatedly been observed to feed.—This may probably form a new genus."

the larvæ of a lace-wing fly (*Chrysopa*),* and a little beetle *Scymnus punctum*.

The present season, on account of the dry weather, has been very favorable for the increase of the red spider; but these three insects, of which the little beetle has been the one most important, have kept it so well under control that it has done very little damage.

The larva of *S. punctum* was first observed on Aug. 7 on *Morus rubra*. The red spider was well distributed over the leaves of this plant, but had not become so bad as to do serious damage. The *Scymnus* increased rapidly and was soon found in all stages. The mites soon began to decrease, so that on Aug. 23 none could be found on the mulberry trees. On Aug. 29, neither *Scymnus* nor mites could be found in the mulberry grove. About the same state of affairs was repeated on the lindens (*Tilia*). Red spiders have usually been very bad on *Manihot utilissima* and *Ficus Parcelli*, and attacked these plants badly early in the present season. Aug. 16, *S. punctum* was found in all stages on the plants, increasing so rapidly that the mites soon began to decrease in numbers, and by the last of August were not numerou senough to do much damage to the plants. These mites next appeared on the moon-vines (*Ipomea bona-nox*) in great numbers. The little beetle soon followed, and, finding such an abundance of food, increased rapidly. There are now (Sept. 24th) very few of the mites on these vines, and *Scymnus* is decreasing in numbers.

This Coccinellid beetle apparently goes through all of its transformations on the plant on which its food is found, but I have not found the egg, and hence cannot give the number of moults nor the length of the larval state. In instances where I have had opportunity to observe it, the pupal state lasted four to five days. I have seen a half dozen of these pupæ attached to a single leaf of the moon-vine. I have bred no parasites from this beetle, and only in one instance have I observed any enemy to attack it; this

* I have seen one of these larvæ devour 110 of the mites at a single meal and it was still eating when I left it on account of darkness. Next day a full-grown web-worm was placed in the box in which this larva was confined. The ravenous little fellow soon attacked the web-worm, thrusting its long mandibles into the posterior segment of the web-worm, which remained quiet for some time; but finally, bringing its head around, grasped its tormentor by the thorax with its mandibles and crushed it to death.

was the larva of *Chrysopa*, before mentioned as feeding on the red spider, and which I also observed destroying a pupa of our little *Scymnus*.

The beetle when first excluded is nearly white, but soon assumes the dark color characteristic of it. The original description of the imago is as follows:—

Scymnus punctum.*—On account of its size and form it resembles the preceding (*S. nanus*), but the coarsely punctured thorax distinguishes it. Rounded oval, convex, shining black, covered with fine and sparse pubescence. Head obsoletely punctulate, antennæ yellow. Thorax finely and sparsely punctured at the middle, coarsely and densely at sides, base margined, obtuse in the middle, subsinuate each side. Elytra finely and sparsely punctured. Body beneath coarsely punctured, abdominal plates smooth, punctured at base, considerably shorter than the segment, not extending laterally to the parapleuræ. Feet testaceous-yellow, four posterior thighs piceous. .05 in. long.

Although the transformations of other species have been described, I append descriptions of the larva and pupa of *S. punctum* as they were observed at the Garden.

Full-grown larva 2.5 mm. long, salmon-colored to dark sooty brown, with 13 segments exclusive of head. Thoracic segments with two dorsal rows of low, broad elevations, pilose, with many black dots and blotches. Abdomen with four longitudinal rows of tubercles, brown-pilose from numerous black dots; the anal segment paler, without tubercles, and used as a proleg.—Described from six living specimens.

Pupa 2 mm. long, showing the members of the beetle, tapering from base of thorax so as to be triangular in general outline; from salmon-colored becoming dark brown, the wings and thorax darkest; sparingly covered with spreading hairs which usually bear near their ends small globules of what appears to be a liquid. Anal segment covered by the cast larval skin, by which the pupa is suspended.—Described from six living specimens.

In closing, I wish to acknowledge the kindness of the Entomologists of the Division of Entomology at Washington, and of Prof. A. J. Cook and Prof. J. H. Comstock, who have aided me by the identification of species and looking up literature to which I did not have access. I am also indebted to Prof. Wm. Trelease for many hints.

The drawings were made under my direction by Mrs. Maggie H. Duffey.

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* Le Conte, Proc. Acad. Phil. vol. vi, p. 141.

EXPLANATION OF PLATES.

PLATE X.

Plochionus timidus, Haldeman.

A. — Full-grown larva × 4.
B. — Head of same, ventral view × 25.
C. — Leg of same × 25.
D. — Diagram showing arrangement of plates on abdomen; S. spiracles.
E. — Diagram showing four ventral and two latero-ventral plates.
F. — Pupa, dorsal view × 4.
G. — Pupa, side view × 4.
H. — Pupa, ventral view × 4.
I. — Imago × 4.

PLATE XI.

Scymnus punctum, Lec.

A. — Larva × 25.
B. — Last four segments of same, lateral view × 25.
C. — Pupa, dorsal view × 25.
D. — Imago × 25.
E. — Leg of same × 25.
F. — Mandible of same × 25.
G. — Antenna of same × 25.
H. — Maxillary palpus of same × 25.